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HOW TO TEACH BEGINNING READING. IV¹

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VI. SCIENTIFIC INVESTIGATIONS OF READING

Divisions of this section.—The following features of the scientific investigations of reading will be considered briefly in this section in order to give some of the scientific background for the practical discussions found in the earlier articles. (1) Laboratory studies of word-recognition and of eye-movements. (2) Tests and scales for measuring oral and silent reading. (3) Conclusions from scientific investigations. These conclusions concern the relation of oral and silent reading, the value of phonetic instruction, the needs of pupils who read poorly, and the nature of reading as active, selective thinking.

LABORATORY STUDIES OF WORD-RECOGNITION AND OF EYE-MOVEMENTS

Experiments on flash recognition.—In the earlier accounts of first-grade lessons, we described methods of teaching children to recognize whole words at a glance, with no previous training in the alphabet or in spelling or phonetics. This practice is quite contrary to the old-fashioned idea that children had to know the letters before they could learn words. The obvious success of the children is sufficient proof of the possibility of whole-word recognition; but certain psychological experiments help to confirm our belief in the importance of such practice. Some of the earliest experiments upon such flash recognition of words were conducted by exposing letters and words to view for a measured fraction of a second. It was found that a long familiar word could be recognized at a glance; but if disordered letters were displayed, it took much longer to make them out.

¹ This is the fourth and last of a series of articles on this topic. The first three gave sample lessons and general principles. Reprints of the series may be purchased from the Department of Education, University of Chicago, for 40 cents each, post-paid; in lots of 25 or more up to 100, 35 cents each; in lots of 100 or more, 30 cents each.

Span of recognition of poor and good readers.—Similar experiments were used later in diagnosing the differences between children in reading ability. Thus, at the University of Chicago in 1916, special studies were made of the "span of recognition" of poor readers and good readers. It was found that when six words were exposed for about one-fifth of a second, a good reader recognized on the average more than *five* of the words, while a poor reader recognized less than *two* words. These experiments explain the

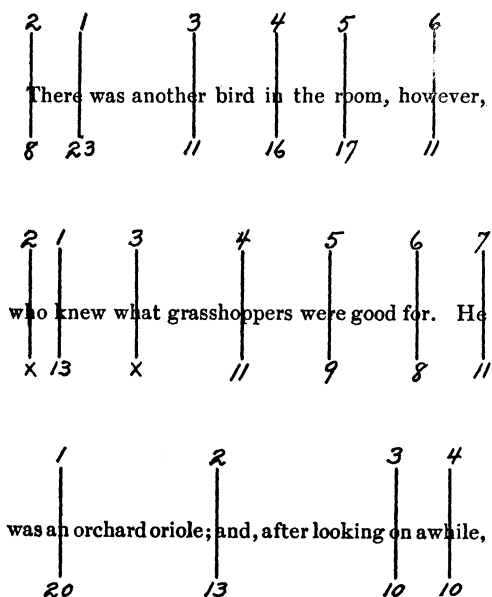


FIG. 1.—Silent reading by a rapid reader in the fourth grade. Each vertical line indicates one pause. The top number indicates the number of the pause and the bottom number its duration in fiftieths of a second. X indicates that it was impossible to determine with precision the length of the pause.

value of flash drills in the rapid recognition of words on cards as a means of speeding up pupils' recognition of familiar words. Experiments in the University of Chicago laboratory showed that such practice was helpful as high as the fourth grade.

Experiments in photographing eye-movements. Huey's notable book.—In the descriptions of the first lessons in book reading it was noted that the children used a manila paper line-marker to

guide their eyes along the line. This practice illustrates the recognition by psychologists that eye-movements are a fundamental factor in reading. The early efforts to study these movements began with simple observations of the eyes of a person while reading. If you will make such observations, you will see that the eyes proceed by jerks and pauses as they read a line, and then make a long sweep back to the beginning of the next line. One of the pioneer investigators of these movements was E. B. Huey,

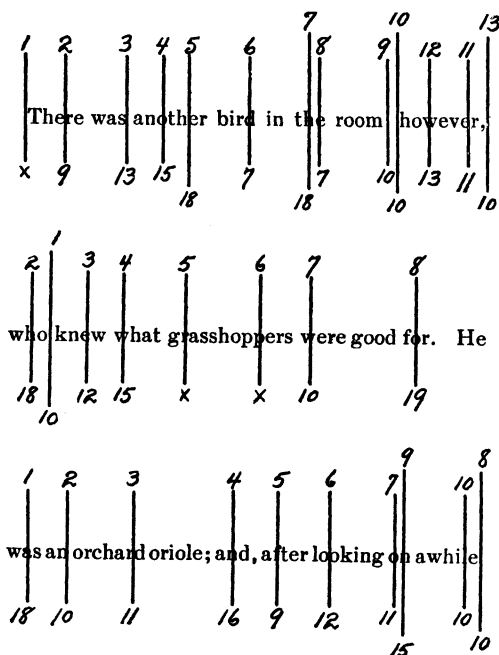


FIG. 2.—Silent reading by a poor reader in the fifth grade. X indicates that it was impossible to determine with precision the length of the pause.

who published in 1908 a book entitled *The Psychology and Pedagogy of Reading* (Macmillan Co.). This book was widely read by persons interested in the teaching of reading and is still one of the best sources of information about the history, psychology, and teaching of reading.

Judd's elaborate studies.—The most elaborate photographic studies of eye-movements have been made during recent years

at the University of Chicago, under the direction of Professor C. H. Judd. The special apparatus used cost approximately \$6,000, funds for the purchase of which were furnished by the General Education Board. One professor of education, on leave of absence from another institution, spent a whole year designing improved apparatus and making photographic records of the eye-movements of many adults and children. Several graduate students also conducted elaborate experiments. An account of the results of these experiments, together with much other material, was given by Judd in a monograph entitled *Reading: Its Nature and Development*, published in 1918. During 1921 Professor Judd was granted \$15,000 by the Commonwealth Fund to carry further these experimental investigations.

Poor reader may pause twice as often as good reader.—In these experimental studies of eye-movements, the most striking contrasts appear between good and poor readers in (1) the *number* of pauses which they make in reading a line, and (2) the amount of *confused eye-movement* that occurs. We cannot here consider these characteristics in detail, but we may note the difference between a good reader and a poor one in the number of pauses, as illustrated in Figures 1 and 2.¹ Each vertical line indicates a pause. It will be noted that the good fourth-grade reader paused only six times in reading the first line, while the poor fifth-grade reader paused thirteen times. Later in the article, we shall have occasion again to refer to the results of such experimental studies of eye-movements.

TESTS AND SCALES FOR MEASURING ORAL AND SILENT READING

Measuring reading is a complex matter.—Another type of investigation of reading has been the construction of scales for measuring the rate and quality of reading. In the case of handwriting or spelling, the construction of scales is comparatively easy, owing to the simplicity of the subject-matter. In the case of reading, the opposite is true. The complete measurement of skill in reading is very difficult on account of the complexity of

¹ Reproductions of Plates XXVII and XXX in *Reading: Its Nature and Development* by Charles Hubbard Judd, pp. 63 and 67.

the subject-matter and of the interpretative reactions of the pupils. However, great progress has been made in devising scales for measuring reading ability, and we shall note briefly a few of those which have been published.

Oral reading tests and scales. Gray's standardized paragraphs.—One of the most widely used scales for measuring ability in oral reading is that devised by Professor W. S. Gray of the University of Chicago. In testing ability in oral reading, the pupil is required to read certain standard paragraphs out loud to an observer who makes a written memorandum of the following factors in the reading: (1) The amount of time consumed; (2) the number of errors made: (a) gross mispronunciations, (b) minor mispronunciations, (c) omission of words, (d) insertion of words, (e) repetition of words or groups of words, and (f) substitution of one word or group of words for another.

Sample paragraphs illustrating increasing difficulty.—The material which the pupils read in this test consists of a series of short paragraphs which gradually increase in difficulty. The second, sixth, and eighth paragraphs are here reproduced.

2

Once there was a little pig.

He lived with his mother in a pen.

One day he saw his four feet.

“Mother,” he said, “what can I do with my feet?”

His mother said, “You can run with them.”

So the little pig ran round and round the pen.

6

The part of farming enjoyed most by a boy is the making of maple sugar. It is better than blackberrying and almost as good as fishing.

One reason why a boy likes this work is that someone else does most of it. It is a sort of work in which he can appear to be very industrious and yet do but little.

8

The crown and glory of a useful life is character. It is the noblest possession of man. It forms a rank in itself, an estate in the general good will, dignifying every station and exalting every position in society. It exercises a greater power than wealth, and is a valuable means of securing honor.

One may easily note the progressive growth in difficulty. The twelfth and final paragraph, which is sufficiently difficult to test even high-school pupils, reads in part as follows:

The hypotheses concerning physical phenomena formulated by the early philosophers proved to be inconsistent and in general not universally applicable.

Humorous illustration of a pupil's experience with the test.—The pupil who is being tested reads successive paragraphs until he makes seven errors in each of two paragraphs. The increasing difficulty for the pupil is illustrated by the case of a boy who had been subjected to a number of medical examinations shortly before he encountered the oral-reading test. As he progressed through the paragraphs, and these became harder and harder, he stuttered and stammered, backed up, hesitated, and finally said to Mr. Gray: "I don't know what you're looking for, Mister; but whatever it is, I've sure got it."

Standard scores derived from wide use of the test.—While devising and standardizing these tests (about 1915), Gray tried them out extensively and carefully in thirteen cities in Illinois. Later they were used in surveys of reading in Cleveland, Grand Rapids, St. Louis, and Indianapolis. From the results of thus testing thousands of children in the oral reading of the same paragraphs, there has been derived a series of standard scores or achievements

which we can use in evaluating the success of the teaching of oral reading in any room, school, or system of schools. At the same time, we can use the tests and scores in diagnosing the needs of particular pupils and determining necessary changes in methods of teaching reading. We shall refer to some of the results of such studies of methods of teaching after noting examples of tests for measuring silent reading.

Silent-reading tests and scales. Courtis tests.—One of the best known and most convenient silent-reading tests is that of S. A. Courtis, of Detroit. This test is given to a class as a whole, which renders it more easy to administer than an oral-reading test which must necessarily be given individually. In the Courtis test, each child is given a little pamphlet containing a story and directions for reading it. In the first part of the test, upon a signal from the examiner, the pupils begin to read. At the end of each half minute, the examiner says, "Mark," whereupon each pupil draws a circle around the last word and goes on reading. From such records the *rates* of silent reading can be calculated.

Quality of pupil's studious comprehension tested by questions.—The second part of the Courtis test measures the quality of the pupil's silent reading by having him write the answers to a number of printed questions about the story. The material for this part of the test is printed in the back of the pamphlet and is divided into paragraphs followed by questions as indicated in the following sample:

When the day of the party came, Daddy planted a May-pole and Mother tied it with gay-colored ribbons. There were to be games and dances on the grass and a delicious supper, with a basketful of flowers for every child.

1. Were the children to have anything to eat?
2. Were they going to play on the grass?
3. Were they going into the house to dance?
4. Were the baskets to be full of flowers?
5. Was it Daddy who tied the ribbons to the pole?

Both rapidity and quality of comprehension measured.—There are some fourteen paragraphs similar to the foregoing in the story, and a total of about seventy questions. The time is limited so that even the best pupil will not complete the test; but all may do several minutes of work, thus giving them time really to get into the

swing of the task. The directions say, "Do not guess at the answers. If you do not remember what the story said, read the paragraph just above the questions again and again until you find the right answer." Thus the test measures both the rapidity and the accuracy of the pupil's comprehension.

Great variety of silent-reading tests. From word-recognition to solving problems.—A somewhat similar test was published by Professor E. L. Thorndike, of Columbia University, in 1914, and the results used by him in a number of articles in which he discussed the mental processes of pupils in understanding or misunderstanding sentences. Numerous other tests have been devised to measure various phases of reading, varying from the mere ability to recognize words to the ability to solve puzzle problems expressed in words.¹ Instead of discussing these varying types of tests, it will be more to our purpose to turn to a brief study of the ideas concerning the methods of teaching reading which have been derived from both the experimental laboratory studies of reading described earlier in the article and the use of tests and scales which we have just been considering.

CONCLUSIONS FROM SCIENTIFIC INVESTIGATIONS

Differences in oral and silent reading. Silent rate usually exceeds oral after fourth grade.—One of the important facts that early appeared from the use of standard tests of the reading of school children was that the rate of silent reading becomes more rapid than the rate of oral reading somewhere in the middle grades. We had one example of this fact in the second-grade lesson described in which a bright boy had already reached the stage in silent reading where he read second-grade material more rapidly than the pace of good oral reading. In the case of most pupils, this change comes in the third or fourth grade, depending upon the natural talent of the pupil and the methods used in teaching reading. After this point in the grades, most pupils will read more rapidly silently than orally. A pupil's rate in careful oral reading will never

¹ Probably the most convenient source from which to purchase school tests in all subjects is the Public School Publishing Company, Bloomington, Illinois. Write for their catalogue of tests. They co-operate with the very efficient Bureau of Educational Research of the University of Illinois in marketing selected tests.

exceed that of clear pronunciation, whereas his silent rate may advance far beyond this, becoming as high as 375 words per minute when he reaches high school if he is a specially skilled reader. This means that he could read a page of the length of this one, if it contained ordinary story material, in about one minute. To read it orally, at the ordinary pace, would take two minutes.

Photographs show differences in eye-movements in silent and oral reading.—One of the most objective and impressive demonstrations of the differences between a pupil's reading processes in silent reading and in oral reading is found in the photographic records of eye-movements. A clear case is shown in Figures 3 and 4,¹ which represent the eye-pauses of the same pupil in silent and in oral reading. In the silent-reading record it appears that the pupil's eyes in reading each line made only four stops and at very regular spatial intervals. In the oral-reading record, it is shown that his eyes made from seven to fourteen stops in a line and at quite irregular intervals.

Overemphasis on oral reading may interfere with silent.—Thus we have derived from the scientific investigations two important lines of evidence on the relation of oral and silent reading. The school tests show us where, on the average, the silent rate begins to exceed the oral; and the photographic records of eye-movements show how many more eye-pauses occur in oral than in silent reading. From such evidence investigators conclude that the common emphasis upon oral reading above the third grade seriously interferes with the development of habits of skilled silent reading, and that it would be better to give various types of practice especially suited to develop skill in silent reading.

Necessity of phonetic training shown by investigations.—Another useful point that has been determined by the scientific investigations is the necessity of special training in the accurate recognition of new words, such as the phonetic training described in the preceding articles. This fact appeared most clearly in Gray's survey of the results of teaching reading in one of the Middle-West cities that maintains an excellent school system. Like several progressive

¹ Reproductions of Plates XXXIII and XXXVIII in *Reading: Its Nature and Development* by Charles Hubbard Judd, pp. 72 and 78.

schools of recent years, this system tended to neglect the so-called "formal" phonetic drill in word-recognition. The fallacy of this neglect appeared when their results in reading were compared with those from other cities as measured by Gray's tests. In speaking of the situation in this particular city, Gray says:

The results of the oral-reading tests showed that the pupils . . . ranked low in accuracy of pronunciation and in ability to attack new words. Classroom observations revealed similar weaknesses. . . . Many teachers had no

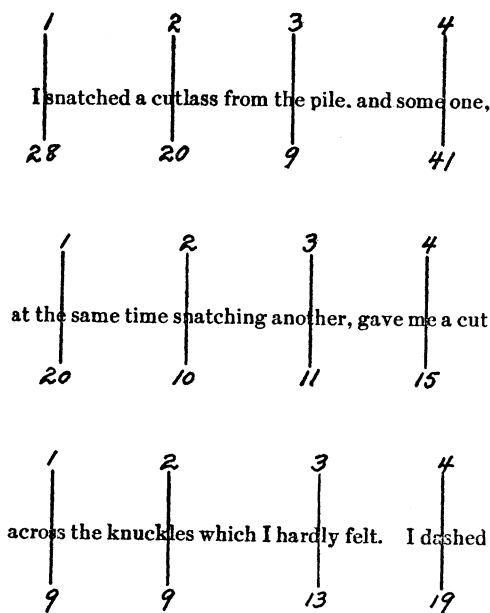


FIG. 3.—Silent reading by a good reader in the seventh grade

[phonetic] devices [for helping pupils], and some were almost helpless, if not inaccurate, in their attempts to aid the pupil. Several principals stated that many teachers had little or no knowledge or training in regard to the use of phonics. As evidenced by the facts cited above, there is real need of giving the problem of word analysis serious consideration in [this city]. Uniform methods of developing independence and accuracy in pronunciation should be considered, and teachers should be trained to make effective use of the adopted method.¹

Diagnosis of needs of poor readers by means of scientific devices.—The scientific devices for measuring reading ability which were

¹ *Elementary School Journal*, XIX (March, 1919), 511-12.

described earlier not only aid in the broad study of the average efficiency in reading instruction as illustrated in the foregoing quotation, but are also especially useful in diagnosing the needs of pupils who are having special difficulties with reading. A number of excellent investigations of types of poor readers have been published. Below is a paraphrase of Judd's description of the reading defects of a poor fifth-grade reader whom we shall call Grace, and the methods used to improve her reading. She

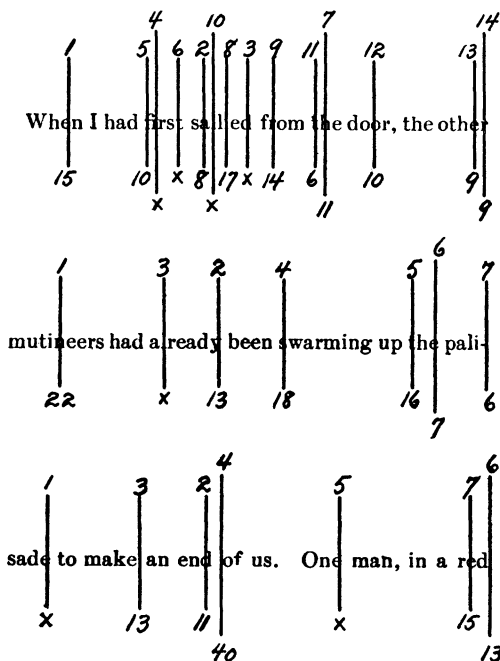


FIG. 4.—Oral reading by the pupil whose record for silent reading is shown in Fig. 3.

had attended three different schools up to the time of entering the University of Chicago Elementary School.

Disliked silent reading.—Grace had been included in the tests . . . and proved to be a slow, inefficient reader. . . . She could not unravel the intricacies of the printed lines which proved easy to many of her classmates. . . . The school physician's record showed that she was a normal, healthy child with no special defects

in eyes, ears, or throat. . . . Silent reading was particularly distasteful to her. She always settled down to it reluctantly. . . . From the home came the same story. "She has never read a story to herself, although she has several attractively illustrated children's books. She frequently, however, after eagerly studying the illustrations in a new book, begs to have the story read to her, saying, 'You read it, mother. I can't understand it very well when I read it myself.'"

Tests revealed special difficulties.—The various tests given to Grace revealed some interesting facts. . . . The pronunciation of unfamiliar words seemed most difficult. She usually hesitated a moment before attacking a new word and then whispered to herself the spelling of the word, letter by letter. . . . Her rate in silent reading showed an unusual condition. It was slower than the oral rate. . . . From the data it was evident that her difficulties in reading were due to a lack of familiarity with printed words and a lack of method of working out new or unknown word forms.

Eighteen weeks of special remedial training.—In an effort to help her to overcome this handicap, she was given various types of training during eighteen weeks, namely, six weeks devoted to a great deal of oral reading, six weeks in drills on phonics and in word analysis, and six weeks including a great deal of silent reading.

Later tests and improvements.—The silent and oral-reading tests which had been given before this special practice were repeated. . . . Grace now showed by her whole manner that she felt competent to do the tests. She wrote her answers with a precision and directness not at all characteristic of her earlier tests. . . . Her teachers reported that she now read with much greater ease and fluency of expression. . . . She seemed to enjoy reading silently much more than before training. . . . Frequently she expressed a preference for reading a passage silently, saying, "I can do it faster."¹

Individual cases reveal need of balanced training plus individual attention.—The foregoing statements give merely the bare out-

¹ Charles Hubbard Judd, *Reading: Its Nature and Development*, "Supplementary Educational Monographs," Vol. II, No. 4, pp. 82-89. Chicago: University of Chicago, 1918.

lines of the diagnosis and treatment of this case. A thorough reading of the whole account as given by Judd, together with accounts of many other cases, is desirable in order to get some comprehension of the complexity of reading habits and processes, and of the varied needs of poor readers. One pupil may read poorly because of absence during certain crucial months in the primary grades when the fundamentals of phonetics were being taught. Another may read poorly because he has had too exclusive phonetic training and never acquired correct habits and skill in interpreting the meaning of printed words. However, in spite of this variety of needs and processes, the difficulties of poor readers may be roughly classified into certain types, for which a well-organized system of teaching reading will provide by balancing the mechanical and interpretative features of the training as outlined in the preceding articles. When an individual pupil, because of absence or mental peculiarity, fails to profit from such balanced training, he should be carefully tested and appropriate individual training should be given him.

Investigators emphasize reading as a tool in acquiring ideas.—Up to this point in our discussion of the results of scientific investigations of reading, we have considered the following matters: (1) the difference between oral and silent reading and the consequent need of specific training in silent reading; (2) the defects of systems that neglect phonetic training and the need of such training; (3) the diagnosing of the needs of especially poor readers by standard tests and the means of correcting special defects. Finally, we may note how investigators of reading processes have come more and more to consider reading as a tool to be used in acquiring ideas and as a process involving careful, controlled thinking instead of mere passive perusal of a page.

Thorndike discusses processes of understanding sentences.—Professor Thorndike's tests of the understanding of sentences, as previously noted, have led him to give special emphasis to the idea that good reading involves good thinking. From the returns from his tests, he illustrated at great length the failures of poor readers to think carefully when reading a paragraph to obtain answers to certain questions.

In commenting on the types of errors that pupils make in such a reading test, Thorndike says:

There seems to be a strong tendency in human nature to accept as satisfactory whatever ideas arise quickly—to trust any course of thought that runs along fluently. If the question makes the pupil think of anything, or if he finds anything in the paragraph that seems to belong to the question, he accepts it without criticism. . . . This fishing around in the text for something to use, and its use without reorganization is perhaps the most debased form of selective thinking which school work shows. . . . The extent to which it prevails amongst pupils in even the higher grades shows the need for practice in reading and study. I am inclined to think, however, that the cure for it is not to repress the verbatim use of wrong, irrelevant or roughly appropriated quotations, but to permit it plus careful examination of the quotations to see if they really do meet the need. . . . The comprehension of text books . . . [is] far above the level of merely “passive” or “receptive” work. When the reading of text books . . . is really passive or receptive, comprehension will rarely result. . . . “To read” means “to think” as truly as does “to evaluate” or “to invent” or “to demonstrate” or “to verify.”¹

Conclusion.—This quotation is quite typical of the recent tendency among progressive investigators to think of reading processes not merely in terms of the special “reading period” but also in terms of what the pupils do with their textbooks and supplementary books in geography, history, science, arithmetic, and every other subject. In order to develop skill in the silent reading of such material, many types of teaching technique and devices are being organized in progressive schools. The description of these, however, is beyond the scope of this series of articles which is concerned merely with the methods, principles, and scientific investigations² of the teaching of “beginning reading.”

¹ E. L. Thorndike, “The Understanding of Sentences,” *Elementary School Journal*, XVIII (October, 1917), 98-114.

² A reference which will supply the reader with further material, summarizing in attractive, usable form the conclusions from many of the recent scientific investigations, is as follows: William S. Gray, “Principles of Method in the Teaching of Reading as Derived from Scientific Investigation,” *Eighteenth Yearbook of the National Society for the Study of Education, Part II*. Bloomington, Illinois: Public School Publishing Co., 1919. \$1.10.

[NOTE.—In response to inquiries, we may say that the Garboard Chart or rack for holding word cards and phrase strips described in an earlier article is now known as the Plymouth Chart and is sold by the Plymouth Press, 6749 Wentworth Avenue, Chicago, Illinois, for \$4.00. It contains grooves for holding twelve strips of reading matter.]